

as in Example 1 ["Acrylic Cover"] and as in Example 2 ["MonoKote™ Cover"] is operated according to the invention, and maintained in the second stage for various times t.

The results are shown in Table 1.

TABLE I

t (sec)	Sample Reproducibility	
	Acrylic cover Sample Peak Area RsD (n = 5)	MonoKote™ cover Sample Peak Area RsD (n = 5)
.050	1.57%	4.94%
.100	1.26%	1.45%
.200	1.10%	1.04%
.500	0.64%	—

OTHER EMBODIMENTS

Other embodiments are within the claims.

For example, other geometrical arrangement of the channels at the intersection may be used, and more than four microchannels may be in fluid communication with the intersection. For example, the intersection need not form a cross of two pairs of aligned microchannels, and the respective microchannels need not intersect at right angles, as shown in the Figs. The channels need not all intersect at a mutual point; the intersection may itself constitute a microchannel segment, so that an offset T configuration results.

And, for example, as noted in the summary of the invention, fluid need not be drawn through the intersection from the buffer supply channel during the second stage; instead, the potential at the buffer supply reservoir may be allowed to float during the second stage, or adjusted to some fixed or variable intermediate potential (rather than at ground, as shown in the Figs.), so that substantially no carrier liquid moves into the intersection, at least during the earlier part of the second stage.

As will be appreciated, the rate and timing of movement of the contents of the various segments of the microchannels at the various stages can be controlled with considerable precision by adjusting and changing the magnitudes of the electrical potentials at the respective electrodes. To a good approximation, substantially no movement of liquid from a reservoir through a microchannel segment into the intersection will result whenever the electrical field strength between the reservoir and the intersection is approximately zero; and a more rapid movement through the segment will result from a higher potential difference. The potentials required to produce the desired resultant flows in the various segments can accordingly be estimated by treating the microchannel structure as an arrangement of interconnected electrical resistors, and applying principles of electrical circuit analysis to the system. To a reasonable approximation, for example, for a microchannel segment of a given cross-section dimension and containing a given liquid carrier, the electrical resistance is proportional to the length of the segment.

In some embodiments the contents of the microchannels have a relatively low viscosity, so that application of an electrical potential to a microchannel segment results in both bulk flow by electroosmosis and electromigration of charged particles within the liquid by electrophoresis. Bulk flow phenomena may predominate, for example, where the channels are filled with buffer at the outset, and where the liquid carrier and sample liquid are buffer solutions. In other

embodiments the microchannels (or at least some of them) can be filled with an electrophoretic medium that has sieving properties; such media characteristically have a higher viscosity, and where such media are employed, the extent of bulk flow resulting from application of an electrical potential is reduced. The microchannels may be charged at the outset with a viscous polymer, for example, or with an electrophoretic gel medium such as a polyacrylamide or an agarose, and in such instances the extent of flow of charged materials by electrophoresis predominates, and there may be substantially no bulk flow. Or, the surfaces of the microchannel walls may be fabricated of a material that is characterized by reduced electroosmotic flow, such as for example an electrically neutral polymer or plastic. Here, too, the extent of bulk flow may be substantially reduced.

It is evident from the above results and discussion that improved methods for transporting materials in microchannel structures are provided.

All publications and patent applications cited in this specification are herein incorporated by reference as if each individual publication or patent application were specifically and individually indicated to be incorporated by reference. The citation of any publication is for its disclosure prior to the filing date and should not be construed as an admission that the present invention is not entitled to antedate such publication by virtue of prior invention.

Although the foregoing invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it is readily apparent to those of ordinary skill in the art in light of the teachings of this invention that certain changes and modifications may be made thereto without departing from the spirit or scope of the appended claims.

What is claimed is:

1. A method for transporting a liquid sample containing at least one sample material into a third microchannel from an intersection of said third microchannel with at least a first, a second, and a fourth microchannel, comprising:

in a first stage, moving liquid sample in and from said fourth microchannel through said intersection and into said second microchannel and concurrently moving carrier liquid in and from said first microchannel and in and from said third microchannel through said intersection and into said second microchannel; thereafter

in a second stage, moving at least part of the contents of said intersection into said third microchannel and concurrently moving a part of the contents of said second and fourth microchannels through said intersection and into said third microchannel, whereby a quantity of said sample material is moved into said third microchannel; and thereafter

in a third stage, moving carrier liquid from said first microchannel simultaneously through said intersection and into said second, third, and fourth microchannels.

2. The method of claim 1 wherein the second stage is maintained for a time t, and whereby the magnitude of said quantity of liquid sample moved into said third channel is greater for greater t.

3. The method of claim 2 wherein t is at least about 0.01 seconds.

4. The method of claim 1 wherein said moving in each said stage is induced by establishing an electrical field within the liquid contents of at least a segment of at least one of said microchannels.

5. The method of claim 4 wherein a reservoir is provided in fluid communication with an end of each said microchan-